PROC. ENTOMOL. SOC. WASH.
92(1), 1990, pp. 44–57

DESCRIPTIONS, DISTRIBUTION, AND HOST-PLANT RECORDS OF EIGHT FIRST INSTARS IN THE GENUS *TOUMEYELLA* (HOMOPTERA: COCCIDAE)

B. J. Sheffer and M. L. Williams

Department of Entomology, Alabama Agricultural Experiment Station, Auburn University, Alabama 36849-5413; (current address, BJS) Department of Pediatrics, SUNY-Health Science Center, 750 Adams Street, Syracuse, New York 13210 .

Abstract.—Detailed morphological descriptions of first-instar nymphs of 8 species in the genus *Toumeyella* are presented. Included are illustrations, a key to described species, and discussions of general morphology and species relationships. The first instar of a ninth species *T. sonorensis* (Cockerell and Parrott), historically included in the genus, proved not to be congeneric with the type or other species within the genus. Host plants and distributions are also given.

Key Words: Homoptera, Coccoidea, Coccidae, *Toumeyella*, first instars

The soft scale insect genus *Toumeyella* was first proposed as a subgenus of *Lecanium* Burmeister by Cockerell in 1895 with *Lecanium mirabile* as its type species. Cockerell (1902) later elevated it to generic rank. As currently recognized, the genus *Toumeyella* is composed of 11 described species, 8 of which occur in North America.

Identification of species of *Toumeyella* has been a problem because of a lack of adequate descriptions and keys, as well as apparent host induced and geographical variation in some species. Williams and Kosztarab (1972) and Hamon and Williams (1984) provided descriptions, illustrations, hosts, distributions and biological notes on 5 species occurring in Virginia and Florida, respectively. Included were *Toumeyella cerifera* Ferris, *T. liriodendri* (Gmelin), *T. parvicornis* (Cockerell), *T. pini* (King), and *T. virginiana* Williams and Kosztarab.

Previous taxonomic studies of *Toumeyella* species have focused primarily on adult females, with little attention to other developmental stages. Ferris (1919), in a redescription of *T. mirabilis* (Cockerell), illustrated the first instar in some detail and commented on the spiracular setae, marginal setae, and anal plate reticulation. Heidel and Kohler (1979) presented a brief description and illustration of the first instar of *T. cubensis* Heidel and Kohler. These papers represent the only attempts of describing and illustrating immature stages of *Toumeyella*.

Studies of immature stages of Coccidae are needed to develop complete and sound classification, yet relatively few such studies have been conducted (Howell and Tippins 1973). Classification based solely on adult female characters may produce erroneous phylogenies. For example, the genera *Chionaspis* and *Pseudaulacaspis* were considered closely related until examination of second instar males revealed characters that indicated the genera arose from separate phylogenetic stocks (Takagi and Kawai 1967).

Additionally, extreme host-induced dimorphism can lead to erroneous classifi-

cation. For example, individual *Chionaspis nyssae* Comstock feeding on two different hosts exhibited such diverse morphological characters that they were placed in separate genera (Knipscher et al. 1976). Mobile, nonfeeding first instars are not so influenced by their host as are later developmental stages (Howell 1981). Sibling species and species in complexes may so closely resemble each other as adult females that utilization of immature stages is the only means of separation (Howell 1981). More accurate phylogenies may be produced with the aid of first instar nymphs which exhibit characters often lost or reduced in adult females.

Presented in this paper are detailed descriptions, illustrations and an identification key to first-instar nymphs of 8 species of *Toumeyella*. Distribution and host plant information are given. A discussion of first-instar general morphology, as well as species relationships, is included. The species of *Toumeyella* treated herein occur in North America except *T. nectandrae* Hempel, which is found in Brazil. Three species could not be studied for lack of specimens: *T. cubensis* Heidel and Kohler, a Cuban species; *T. paulista* Hempel, a Brazilian species; and *T. pinicola* Ferris, from the Western United States.

Materials and Methods

Specimens (slide mounted and/or dry) were borrowed from the following institutions: Auburn University (AUEM), Florida State Collection of Arthropods (FSCA), University of California Davis (UCDC), United States National Museum of Natural History (USNM), and Virginia Polytechnic Institute and State University (VPIC).

A minimum of 10 slide-mounted first-instar nymphs were measured for each species description. Measurements were made utilizing a phase-contrast microscope fitted with an ocular micrometer. For each structure measured, the mean and range (parenthetic) are given in microns in each species description. Terminology used in descriptions is from Williams and Kosztarab (1972). Drawings are not made to the same scale in all species nor are dermal structures and enlargements in direct proportion to each other. The scale bar shown in each figure refers only to body size and not to enlargements.

In the Specimens Studied section, the first number indicates the number of slides and the second number (parenthetic) the number of specimens, if different. Collection abbreviations are utilized to indicate specimen deposition in the Specimens Studied section.

General Morphology of First Instar Nymphs

Fig. 1

Body (Fig. 1-A).—Slide-mounted specimens generally oval to elongate-oval, 597 (330–965) long and 354 (215–681) wide. Derm membranous throughout. Appendages, mouthparts, pores and microducts sclerotized. Segmentation.—Head, thorax and abdominal segments closely fused. Segmentation not readily apparent. Antennae (Fig. 1-B).—Antennae well developed, 5-segmented, 3rd and 5th segments generally about equal length. Slender hairlike setae on all segments, with enlarged "stout" sensory setae (Fig. 1-C) on segments 4 and 5. A simple sensory pore (Fig. 1-D) on segment 2. Eyes (Fig. 1-E).—Located on margin just above antennal scape, reduced to a single facet. Mouthparts (Fig. 1-F).—Mouthparts lie between the procoxae, consisting of clypeolabral shield, one-segmented labium with 6–8 setae, and stylet loop. Legs (Fig. 1-G).—Well developed, without tibiotarsal sclerotization or free articulation. Two sensory pores (Fig. 1-H) on each side of trochanter. Various hairlike setae on each segment, and knobbed digitules in pairs on tarsi (Fig. 1-I) and claws (Fig. 1-J) except prothoracic legs with 1 tarsal digitule setiform. Microctenidia (Fig. 1-K) at tibial apex present or absent. Tarsal claw (Fig. 1-L) simple or with a denticle. Spiracles (Fig.

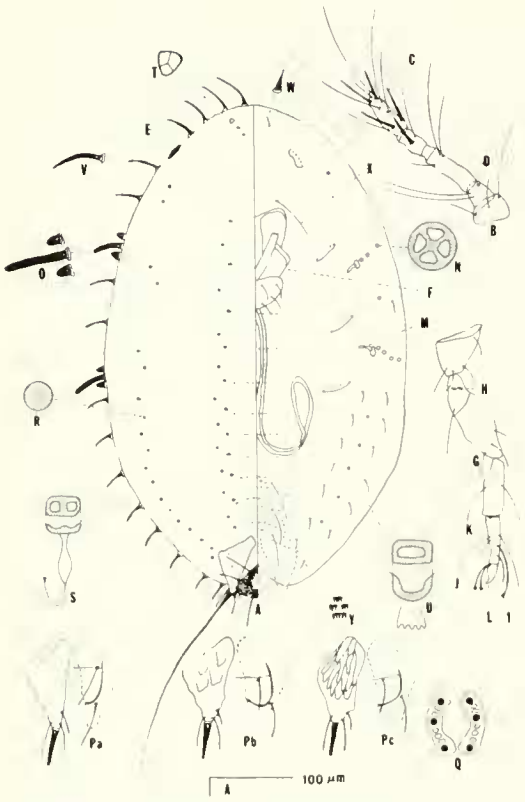

Fig. 1. General morphology, *Toumeyella* first instar.

1-M).—Two thoracic pairs, associated with ventral quadralocular pores (Fig. 1-N) in spiracular furrows; 2–3 pores anteriorly, 3–4 posteriorly. Occasional quinquelocular or 6-locular pore. Spiracular setae (Fig. 1-O).—Three stout spiracular setae in each spiracular furrow in all species except *T. parvicornis* (Fig. 6). Spiracular setae are taxonomically important in separating species. Anal plates (Fig. 1-Pa–c).—Two anal plates, well developed, triangular with rounded angles. Dorsum with surface microspines (Fig. 1-Pa), coarse (Fig. 1-Pb) or dense (Fig. 1-Pc) reticulation. Four dorsal setae per plate; 1 on mesal margin, 3 apical. Thick median apical seta approximately ½ body length. One ventral subapical seta per plate and 1 pair fringe setae on anal fold. Dorsal surface texture of anal plates important in separating species. Anal ring (Fig. 1-Q).—Subcircular to roundly hexagonal with 6 stout anal ring hairs and a row of irregularly shaped pores. Pores.—Small (2 μm dia.), usually simple, dorsal disc pores (Fig. 1-R) in submedian and submarginal longitudinal rows. Dorsal bilocular pores (Fig. 1-S) in submedian and often submarginal longitudinal rows. Bilocular pores categorized as small (longest length 2 μm) to large (longest length 4–8 μm). Dorsal trilocular pore (Fig. 1-T) on derm, anterior to each antennal scape. Ducts.—Ventral microducts (Fig. 1-U) in 2 submarginal longitudinal rows of 5 each on the abdomen, 1 between anterior and posterior spiracular furrows and 1 posterior to each eye. Body setae.—Marginal setae (Fig. 1-V) slender to stout, distribution: 8 anteriorly between eyes, 2–3 on each side between eye and anterior spiracular setae, 2–3 on each side between anterior and posterior spiracular setae, 16 posteriorly on abdomen. Additionally, *T. parvicornis* has 2 setae on the body margin at the apex of each spiracular furrow, which are undifferentiated from marginal setae. Ventral body setae bristlelike, of 2 lengths: submarginal setae (Fig. 1-W) short, in 2 longitudinal rows of 7 each on abdomen, 1 seta between anterior and posterior spiracular furrows and 1 pair at head apex; body setae (Fig. 1-X) long, in 2 submedian rows of 3 each on posterior abdominal segments; with 2 interantennal setae. Other structures.—Ventral microspines (Fig. 1-Y) on posterior abdominal segments.

Key to 8 First-Instar Nymphs of the Genus *Toumeyella*

1. Dorsal bilocular pore clusters present (Fig. 6-C); 44 marginal setae around body; spiracular setae undifferentiated from marginal setae (Fig. 6-B) ..... *T. parvicornis*

1′. Dorsal bilocular pore clusters absent; 32–36 marginal setae around body; spiracular setae distinctly different from marginal setae, 3 in each spiracular furrow (Fig. 1-O) 2

2.(1′) Body with 36 slender marginal setae (Fig. 2-B) ..... *T. cerifera*

2'. Body with 32 slender to stout marginal setae 3

3.(2') Dorsal bilocular pores (2 μm) present in 2 submedian longitudinal rows only (Fig. 4-D); median spiracular setae 5–6 times longer than anterior set of lateral spiracular setae (Fig. 4-C); marginal setae stout ..... *T. mirabilis*

3'. Dorsal bilocular pores (2–8 μm) present in submarginal and submedian longitudinal rows (Fig. 1-S); median spiracular setae approximately 2 times longer than lateral spiracular setae 4

4.(3') Small dorsal bilocular pores (2 μm) present in submarginal and submedian longitudinal rows; tibial microctenidia present (Fig. 1-K) 5

4'. Larger dorsal bilocular pores (>3 μm) present in submarginal and submedian longitudinal rows, predominantly bow shaped (Fig. 8-D); tibial microctenidia absent ..... *T. quadrifasciata*

5.(4) Dorsal bilocular pores (2 μm) present in submarginal, submedian, and intermediate longitudinal rows (Fig. 9-D) ..... *T. virginiana*

5'. Dorsal bilocular pores (2 μm) present in submarginal and submedian longitudinal rows only 6

6.(5') Dorsum of anal plates densely reticulated (Fig. 1-Pc); marginal setae stout; not on *Pinus* sp. 7

6'. Dorsum of anal plates not reticulated, but with sparsely distributed microspines (Fig. 7-H); marginal setae slender (Fig. 7-B); on *Pinus* sp. ..... *T. pini*

7.(6) Dorsal quinquelocular disc pores (2 μm) usually present in submarginal and submedian longitudinal rows (Fig. 3-E); North American ..... *T. liriodendri*

7'. Dorsal quinquelocular disc pores absent; dorsal disc pores simple (Fig. 5-E); Brazilian ..... *T. nectandrae*

Toumeyella cerifera Ferris
Fig. 2

Toumeyella cerifera Ferris 1921: 90. Steinweden 1929: 227, Williams and Kosztarab 1972: 160, Hamon and Williams 1984: 117.

Specimens studied.—*Cephalanthus occidentalis*: 3(13), Sussex Co., Airport Pond, Wakefield, VA, 16 Aug 1969, Michael L. Williams (AUEM); 1, Macon Co., AL, 31 May 1975, MLW (AUEM); 2(8), Macon Co., AL, 21 Jun 1975, MLW (AUEM); 2(21), Macon Co., AL, 13 Jul 1975, MLW (AUEM); 1(3), Macon Co., AL, 24 Aug 1975, MLW (AUEM); 1(2), Macon Co., AL, 13 Oct 1975, MLW (AUEM).

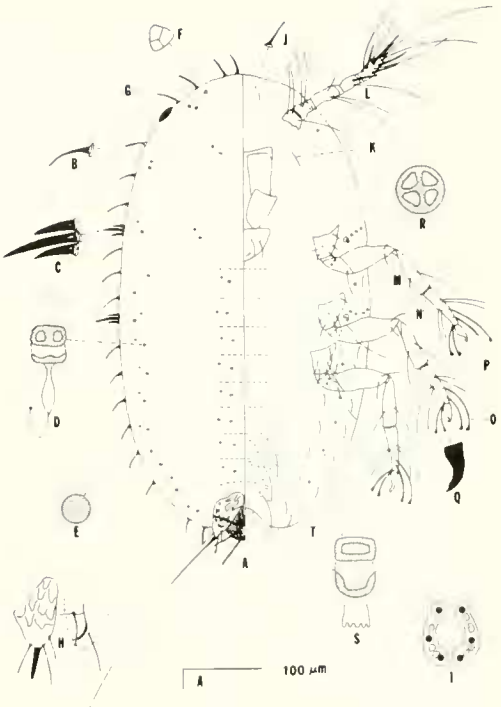

Fig. 2. First instar, *Toumeyella cerifera* Ferris 1921.

Additional host plants and distribution.—*Toumeyella cerifera* was first described from *Albizzia occidentalis* collected in Baja California, Mexico. Reported to occur in AR, FL, LA, and NC.

General appearance.—Body (Fig. 2-A) oval, 642 (514–939) long, 391 (296–610) wide. Dorsum.—Marginal setae (Fig. 2-B) 14 (10–19) long, slender, curved posteriorly, distribution: 8 anteriorly between eyes, 3 on each side between eyes and anterior spiracular setae, 3 on each side between anterior and posterior spiracular setae, 16 on posterior of body. Three spiracular setae (Fig. 2-C) in each spiracular furrow; median setae 24 (19–28) long, lateral setae 14 (11–18) long. Small (2 μm) bilocular (Fig. 2-D) and simple disc (Fig. 2-E) pores in submedian and sub-

marginal longitudinal rows. Anal plates (Fig. 2-H).—Each plate with dorsum densely reticulated, 68 (59–78) long, 34 (28–42) wide; cephalolateral margin 44 (40–48) long, caudolateral margin 41 (28–47) long. Venter.—Antennae (Fig. 2-L) 170 (157–179) long. Legs (Fig. 2-M) 250 (234–268) long, microctenidia (Fig. 2-N) at tibial apex; tarsal digitules (Fig. 2-O) 49 (42–56) and 35 (32–37) long; claw digitules (Fig. 2-P) 23 (17–26) long; claws (Fig. 2-Q) with denticle. Diagnosis.—Thirty-six marginal setae occur only in *T. cerifera* and serve to separate it from all other *Toumeyella*. Forty-four marginal setae are found in *T. parvicornis*, and all other species possess 32 marginal setae.

Toumeyella liriodendri (Gmelin)
Fig. 3

Coccus liriodendri Gmelin 1789: 2220.
Lecanium tulipiferae Cook 1878: 192.
Lecanium liriodendri (Gmelin). Cockerell 1899: 271, Herrick 1911: 12, Carnes 1906: 40.
Eulecanium tulipiferae (Cook). King 1902: 59.
Eulecanium (?) *liriodendri* (Gmelin). Fernald 1903: 190.
Lecanium (*Toumeyella*) *liriodendri* (Gmelin). Pettit and McDaniel 1920: 10.
Toumeyella liriodendri (Gmelin). Sanders 1909: 447, Jarvis and Guelph 1911: 70, Dietz and Morrison 1916: 249, Houser 1918: 301, Berger 1922: 68, Harned 1923: 26, Hollinger 1923: 63, Merrill and Chaffin 1923: 273, Trimble 1925: 6, Wells 1926: 257, Trimble 1928: 44, Steinweden 1929: 227, Felt and Rankin 1932: 460, Doane et al. 1936: 380, Dodge and Rickett 1943: 407, Craighead 1950: 144, Milliron 1959: 28, Pirone et al. 1960: 473, Burns 1970: 1, Burns and Donley 1970: 228, 1971: 532, Donley and Burns 1971: 1, Williams and Kosztarab 1972: 164, Kosztarab 1977: 184, Gill 1982: 1, Hamon and Williams 1984: 119, Gill 1988: 111.

Specimens studied.—*Liriodendron tulipifera*: 1(4), Valley Mills, IN, H. Morrison (UCDC); 1(5), Knoxville, TN, let. 24 Sep 1941, G. M. Bentley (USNM); 1(2), Montgomery Co., Blacksburg, VA, 16 Sep 1968, MLW (AUEM); 1(10), Simpson, IL, 7 Aug 1969, J. E. Appleby (USNM); 1, Green Co., Mt. Morris, PA, 1 Apr 1970, D. P. Burns (FSCA). *Liriodendron*: 2(9), College Park, MD, 9 May 1938, H. S. McConnell (USNM); 1(11), San Jose, CA, 16 Nov 1945, let. E. O. Essig, Foster (USNM). Tulip poplar: 1(12), Kennett Sq., PA, 21 Aug 1950, C. A. Thomas (USNM). Tulip tree: 1(16), Kingston, NY, 10 Aug 1949, J. A. Naegele (USNM).

Additional host plants and distribution.—*Toumeyella liriodendri* probably is native to the North American yellow-poplar area ranging from New York and Connecticut to Florida and west through the Mississippi River Valley (Burns and Donley 1970). It also occurs in California on shade and ornamental plantings of yellow-poplar and magnolia (Williams and Kosztarab 1972).

Toumeyella liriodendri occurs on numerous hosts including: *Magnolia acuminata, M. grandiflora, M. nigra, M. obovata, M. sinensis, M. soulangiana, M. soulangiana* var. *alexandrina, M. stellata, M. virginiana, Michellia fuscata*, and cape jessamine (*Gardenia jasminoides*?). Numerous authors report varied hosts such as *Cephalanthus* spp., *Gardenia jasminoides, Gordonia lasianthus, Juglans* spp., *Tilia* spp. (Donley and Burns 1965), *Magnolia lenni* (Merrill 1953), *Magnolia kobus* (Sleesman 1945), *Ascyrum edinianum, A. hypericoides, A. tetrapetalum, Carya cordiformis, Cassia fasciculata*, and *Hypericum cistifolium* (Hamon and Williams 1984). It is doubtful that *T. liriodendri* occurs on *Cephalanthus* spp., but rather is a misidentification of *T. cerifera* (Williams and Kosztarab 1972). Records on *Ascyrum* spp. and *Hypericum* spp. are most likely misidentifications of an undescribed *Toumeyella* species.

General appearance.—Body (Fig. 3-A)

oval, 559 (506–724) long, 333 (293–521) wide. Dorsum.—Marginal setae (Fig. 3-B) 24 (19–31) long on head tapering to 10 (7–12) long near anal cleft, stout, tapering to a point, often curved posteriorly, distribution: 8 anteriorly between eyes, 2 on each side between eyes and anterior spiracular setae, 2 on each side between anterior and posterior spiracular setae, 16 on posterior of body. Three spiracular setae (Fig. 3-C) in each spiracular furrow; median seta 29 (25–33) long, lateral setae 7 (6–8) long. Small (2 μm) bilocular (Fig. 3-D) and small (2 μm) quinquelocular (Fig. 3-E), occasionally 4- and 6-locular, pores in submedian and submarginal longitudinal rows. Anal plates (Fig. 3-H).—Each plate with dorsum densely reticulated, 66 (58–69) long, 32 (28–37) wide; cephalolateral margin 43 (37–47) long, caudolateral margin 36 (30–41) long. Venter.—Antennae (Fig. 3-L) 161 (150–171) long. Legs (Fig. 3-M) 238 (229–253) long, microctenidia (Fig. 3-N) at tibial apex; tarsal digitules (Fig. 3-O) 48 (42–52) and 34 (27–38) long; claw digitules (Fig. 3-P) 24 (22–25) long; claws (Fig. 3-Q) with denticle. Diagnosis.—*Toumeyella liriodendri* is most similar to *T. nectandrae,* though dorsal multilocular disc pores have only been observed in *T. liriodendri.* All other species have simple dorsal disc pores.

Toumeyella mirabilis (Cockerell)
Fig. 4

Lecanium mirabile Cockerell 1895: 3.
Toumeyella mirabilis (Cockerell). Cockerell 1902: 452, Fernald 1903: 179, Ferris 1919: 45, Ferris 1921: 91, MacGillivray 1921: 181, Steinweden 1929: 227, Williams and Kosztarab 1972: 158, Taber et al. 1975: 439, Ward et al. 1977: 100.

Specimens studied.—Mesquite twigs: 1(7), Nogales, AZ, 21 Apr 1940 (USNM). *Prosopis juliflora* var. *velutina*: 3(8), Tucson, AZ, 11 May 1950, M.E. Elve (UCDC). *Prosopis* sp.: 3(10), Galiuro Mts., AZ, 26 May 1897, Hubbard (USNM); 3, Cochise Co., AZ, 27 Jul 1969, M. Kosztarab (AUEM).

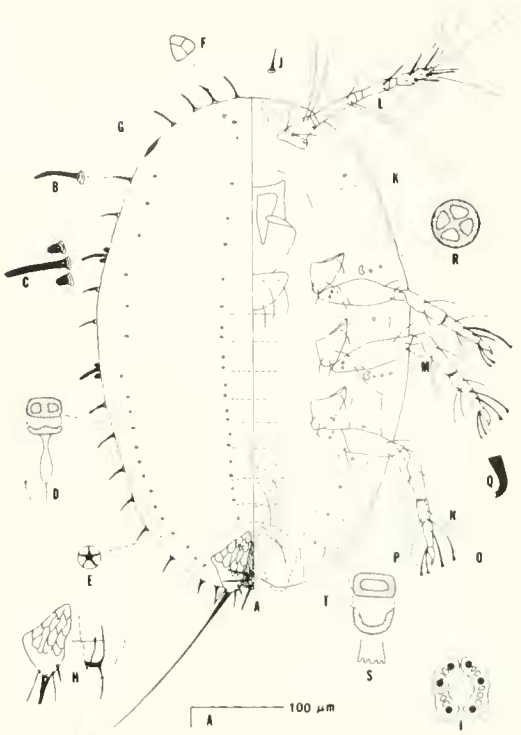

Fig. 3. First instar, *Toumeyella liriodendri* (Gmelin) 1789.

Additional host plants and distribution.—*Toumeyella mirabilis* has also been recorded on *Prosopis glandulosa* and *P. juliflora* var. *glandulosa. Toumeyella mirabilis* has been recorded from NM, TX and Mexico.

General appearance.—Body (Fig. 4-A) oval, 616 (514–847) long, 370 (319–503) wide. Dorsum.—Marginal setae (Fig. 4-B) 17 (11–27) long, stout, tapering to a point, curved posteriorly, distribution: 8 anteriorly between eyes, 2 on each side between eyes and anterior spiracular setae, 2 on each side between anterior and posterior spiracular setae, 16 on posterior of body. Three spiracular setae (Fig. 4-C) in each spiracular furrow; median setae 78 (32–128) long: in anterior set, lateral setae 13 (10–20) long; in posterior set, anterior lateral seta 12 (7–17) long, and posterior lateral seta 21 (9–

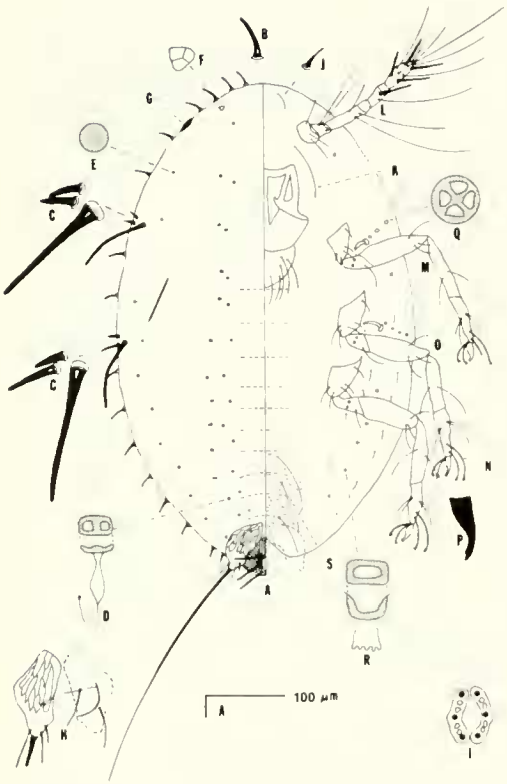

Fig. 4. First instar, *Toumeyella mirabilis* (Cockerell) 1895.

33) long. Small (2 µm) bilocular pores (Fig. 4-D) in a submedian longitudinal row. Simple disc pores (Fig. 4-E) in submedian and submarginal longitudinal rows. Anal plates (Fig. 4-H).—Each plate with dorsum densely reticulated, 78 (72–84) long, 33 (25–38) wide; cephalolateral margin 48 (43–52) long, caudolateral margin 43 (35–48) long. Venter.—Antennae (Fig. 4-L) 170 (157–179) long. Legs (Fig. 4-M) 299 (267–323) long, microctenidia at tibial apex absent; tarsal digitules (Fig. 4-N) 58 (54–61) and 43 (38–46) long; claw digitules (Fig. 4-O) 28 (23–33) long; claws (Fig. 4-P) with denticle. Diagnosis.—The spiracular setae will serve to separate *T. mirabilis* from all other *Toumeyella*. In *T. mirabilis* the median spiracular setae are 5–6 times longer than the anterior set of laterals, small dorsal bilocular pores occur in submedian rows only, anal plates are densely reticulated, and microctenidia are absent. *Toumeyella mirabilis* has only been collected on *Prosopis*.

Toumeyella nectandrae Hempel
Fig. 5

Toumeyella nectandrae Hempel 1929: 64, Lepage 1938: 347.

Specimens studied.—*Nectandra* sp.: 3(24), Sao Roque, S. Paulo, Brazil, 27 Oct 1931, H. S. Lepage (AUEM).

General appearance.—Body (Fig. 5-A) oval, 490 (430–546) long, 282 (247–314) wide. Dorsum.—Marginal setae (Fig. 5-B) 30 (25–37) long, stout, slightly curved posteriorly, distribution: 8 anteriorly between eyes, 2 on each side between eyes and anterior spiracular setae, 2 on each side between anterior and posterior spiracular setae, 16 on posterior of body. Three spiracular setae (Fig. 5-C) in each spiracular furrow; median setae 34 (31–38) long, lateral setae 8 (6–19) long. Small (2 µm) bilocular (Fig. 5-D) and simple disc (Fig. 5-E) pores in submedian and submarginal longitudinal rows. Anal plates (Fig. 5-H).—Each plate with dorsum densely reticulated, 61 (53–67) long, 30 (27–32) wide; cephalolateral margin 37 (28–41) long, caudolateral margin 38 (32–42) long. Venter.—Antennae (Fig. 5-K) 159 (152–165) long. Legs (Fig. 5-L) 231 (211–242) long, microctenidia (Fig. 5-M) at tibial apex; tarsal digitules (Fig. 5-N) 43 (41–46) and 30 (26–32) long; claw digitules (Fig. 5-O) 21 (20–22) long; claws (Fig. 5-P) with denticle. Diagnosis.—*Toumeyella nectandrae* is similar to *T. liriodendri*, but *Toumeyella nectandrae* has simple dorsal disc pores, whereas *T. liriodendri* has multilocular dorsal disc pores.

Toumeyella parvicornis (Cockerell)
Fig. 6

Lecanium parvicorne Cockerell 1897: 90.
Toumeyella parvicornis (Cockerell). Cockerell 1902: 452, Fernald 1903: 179, Wil-

son 1917: 59, Ferris 1920: 42, MacGillivray 1921: 181, Merrill and Chaffin 1923: 274, Williams and Kosztarab 1972: 171, Williams and Cobb 1982: 93, Hamon and Williams 1984: 122.

Lecanium (*Toumeyella*) *numismaticum* Pettit and McDaniel 1920: 8.

Toumeyella numismaticum Pettit and McDaniel. Steinweden 1929: 227, Craighead and Middleton 1930: 17, Orr and Hall 1931: 1087, Felt and Rankin 1932: 390, Doane et al. 1936: 375, Dodge and Rickett 1943: 485, Sleesman 1945: 44, Craighead 1950: 144, Merrill 1953: 110, Rabkin and Lejeune 1954: 570, McIntyre 1960: 325, MacAloney 1961: 1, Smirnoff and Valero 1975: 236.

Specimens studied.—Long leaf pine: 1(10), Alachua Co., FL, 15 Mar 1954, G. Merrill (USNM). *Pinus* sp.: 1(8), Houston Co., AL, 16 Apr 1976, Reafield Vester (AUEM). *P. elliottii:* 1(6), Baldwin Co., Perdido, AL, 12 May 1978, Charles H. Ray (AUEM). *P. montana:* 1(15), Washington, D.C., 17 Jul 1947, Wester (USNM). *P. palustris:* 1(3), Miami, FL, 6 Sep 1977, CHR (AUEM). *P. rigida:* TYPE, 1(2), Lake City, FL, 10 Apr 1897, A. L. Quaintance (AUEM). *P. taeda:* 2(4), Auburn University Insectary, Auburn, AL, 24 Oct 1974, CHR (AUEM). *P. virginiana:* 1(4), Blount Co., nr. Oneonta, AL, 7 Aug 1981, CHR (AUEM). Spruce: 1(3), Mathews Co., VA, 31 May 1968, T. E. Dinwiddie (AUEM).

Additional host plants and distribution.—*Toumeyella parvicornis* occurs primarily on pine species including: *Pinus nigra, P. strobus* (Williams and Kosztarab 1972), *P. banksiana, P. caribaea, P. clausa, P. densiflora, P. echinata, P. glabra, P. heterophylla, P. inops, P. mugo, P. mugo* var. *pumilio, P. mugo* var. *rostrata, P. pinea, P. ponderosa, P. radiata, P. resinosa, P. sinensis, P. sylvestris,* and *Zygocactus truncatus.*

Toumeyella parvicornis has been recorded in most states east of the Mississippi River and north to Manitoba, Canada (Williams and Kosztarab 1972) as well as IA, NB, ND, SD, and WI (MacAloney 1961).

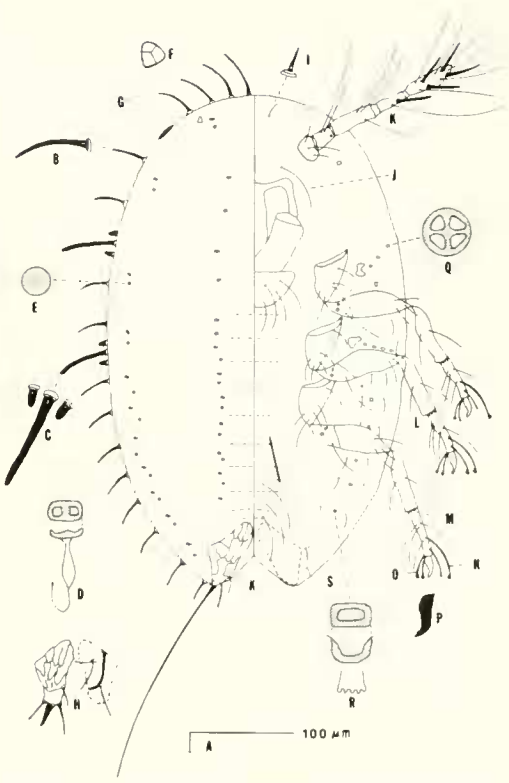

Fig. 5. First instar, *Toumeyella nectandrae* Hempel 1929.

General appearance.—Body (Fig 6-A) oval, 617 (487–902) long, 348 (284–561) wide. Dorsum.—Marginal setae (Fig. 6-B) 17 (12–21) long on head tapering to 13 (9–16) long near anal cleft, slender, curved posteriorly, distribution: 8 anteriorly between eyes, 3 on each side between eyes and anterior spiracular furrow, 3 on each side between anterior and posterior spiracular furrow, 16 on posterior of body. Two setae at apex of each spiracular furrow undifferentiated from marginal setae. Bilocular pore clusters (Fig. 6-C) in a submarginal longitudinal row. Simple disc pores (Fig. 6-D) in submedian and submarginal longitudinal rows. Anal plates (Fig. 6-G).—Each plate

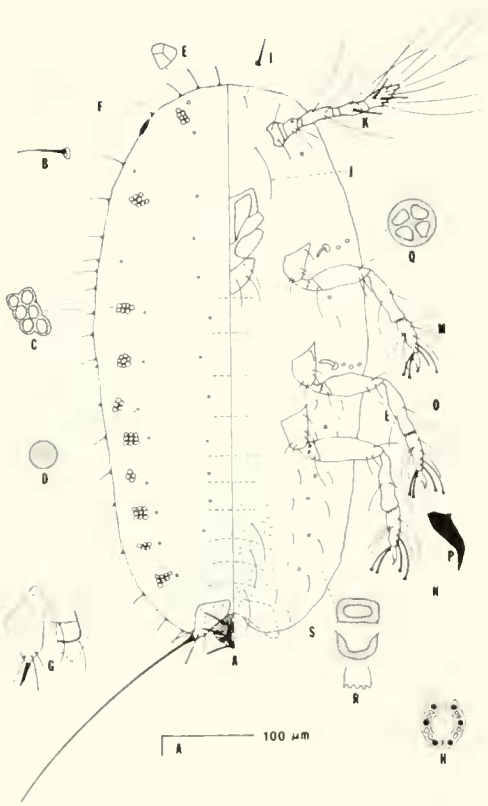

Fig. 6. First instar, *Toumeyella parvicornis* (Cockerell) 1897.

with sparsely distributed microspines on dorsum, 64 (56–70) long, 27 (25–31) wide; cephalolateral margin 36 (30–43) long, caudolateral margin 39 (36–43) long. Venter.—Antennae (Fig. 6-K) 183 (162–207) long. Legs (Fig. 6-L) 249 (231–271) long, microctenidia (Fig. 6-M) at tibial apex; tarsal digitules (Fig. 6-N) 49 (40–57) and 35 (30–39) long; claw digitules (Fig. 6-O) 24 (21–30) long; claws (Fig. 6-P) simple, without denticle. Diagnosis.—Dorsal bilocular pore clusters, spiracular setae undifferentiated from marginal setae, and simple tarsal claws are characteristics unique to *T. parvicornis*.

Toumeyella pini (King)
Fig. 7

Lecanium pini King 1901: 334.
Toumeyella (?) *pini* (King). Cockerell 1902: 452, Fernald 1903: 179.
Lecanium corrugatum Thro 1903: 216, Fernald 1903: 179.
Lecanium (*Toumeyella*) *corrugatum* (Thro). Pettit and McDaniel 1920: 6.
Toumeyella corrugatum (Thro). Harned 1923: 26, Doane et al. 1936: 375.
Toumeyella pini (King). Ferris 1920: 42, MacGillivray 1921: 181, Steinweden 1929: 227, Craighead and Middleton 1930: 17, Doane et al. 1936: 375, Dodge and Rickett 1943: 485, Craighead 1950: 145, MacAloney 1961: 3, Williams and Kosztarab 1972: 171, Hamon and Williams 1984: 124.

Specimens studied.—*Pinus mugo:* 1(2), Oxford, CT, let. of 13 Jul 1939, R. C. Brown (USNM); 1(9), Waynesboro, VA, 31 May 1941, F. R. Freund (USNM). *P. pungens:* 1(2), Blain, PA, 30 July 1959, A. T. Drooz (USNM). *P. taeda:* 1, Auburn, AL, 25 Jul 1974, CHR (AUEM); 1(4), Airport Marsh, Dauphin Island, Mobile Co., AL, 13 May 1978, CHR (AUEM); 1(2), Lee Co., Auburn, AL, 21 Jun 1977, CHR (AUEM). *P. virginiana:* 1(10), V.P.I. Plot 531/d, Blacksburg, VA, 11 May 1969, MLW (VPIC). Red pine: 1(10), Cole Nursery, Tazewell Co., VA, Jun 1957, F. R. Freund (USNM). Pine: 1(3), McConnelsburg area, PA, 10 June 1948, G. Sleesman (USNM).

Additional host plants and distribution.—*Toumeyella pini* has been reported on numerous pine species including: *Pinus contorta, P. resinosa, P. sylvestris* (Williams and Kosztarab 1972), *P. palustris, P. serotina* (Hamon and Williams 1984), *P. austriaca* (Jarvis and Guelph 1911), *P. divaricatus. P. echinata, P. elliottii, P. pinaster, P. rigida,* and *P. strobus.*

The type specimen was collected in NY with subsequent collections in TX (Hamon and Williams 1984), DC, FL, GA, MD, MI, MS, NJ, OH, and SC.

General appearance.—Body (Fig. 7-A) oval, 594 (441–921) long, 336 (264–494) wide. Dorsum.—Marginal setae (Fig. 7-B) 22 (14–32) long on head tapering to 12 (9–15) long near anal cleft, slender, curved posteriorly, distribution: 8 anteriorly between

eyes, 2 on each side between eyes and anterior spiracular setae, 2 on each side between anterior and posterior spiracular setae, 16 on posterior of body. Three spiracular setae (Fig. 7-C) in each spiracular furrow; median setae 21 (19–25) long, lateral setae 7 (5–10) long. Small (2 μm) bilocular (Fig. 7-D) and simple disc (Fig. 7-E) pores in submedian and submarginal longitudinal rows. Anal plates (Fig. 7-H).—Each plate with sparsely distributed microspines on dorsum, 63 (57–73) long, 30 (23–35) wide; cephalolateral margin 38 (31–47) long, caudolateral margin 38 (31–47) long. Venter.—Antennae (Fig. 7-L) 166 (143–183) long. Legs (Fig. 7-M) 237 (219–261) long, microctenidia (Fig. 7-N) at tibial apex; tarsal digitules (Fig. 7-O) 49 (33–56) and 33 (27–36) long; claw digitules (Fig. 7-P) 21 (16–25) long; claws (Fig. 7-Q) with denticle. Biological notes.—*Toumeyella pini* is often found in mixed infestations with *T. parvicornis* (Williams and Kosztarab 1972). Diagnosis.—*Toumeyella pini* appears similar to *T. virginiana*. *Toumeyella pini* has small dorsal bilocular pores in submarginal and submedian longitudinal rows, whereas *T. virginiana* has bilocular pores in submarginal, submedian, and intermediate longitudinal rows.

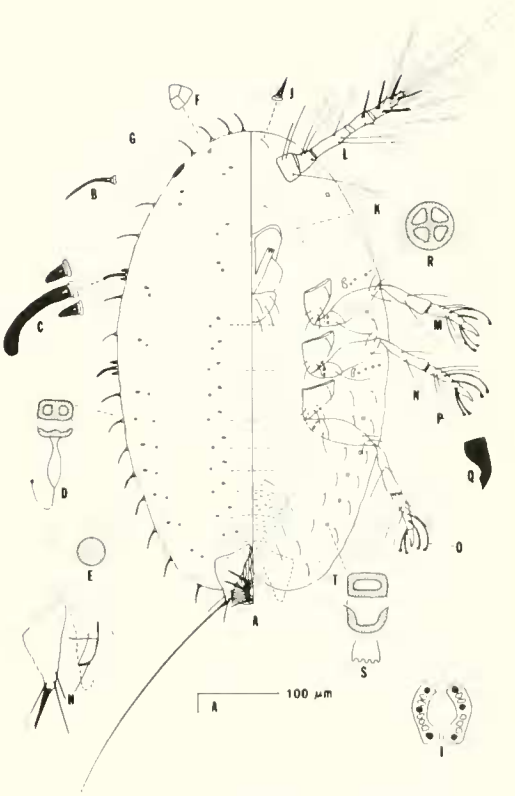

Fig. 7. First instar, *Toumeyella pini* (King) 1901.

Toumeyella quadrifasciata (Cockerell)
Fig. 8

Lecanium quadrifasciatum Cockerell 1895: 3.

Toumeyella quadrifasciata (Cockerell). Cockerell 1902: 452, Fernald 1903: 179, MacGillivray 1921: 181.

Specimens studied.—*Robinia neomexicana:* TYPE, 7(37), Organ Mts., NM, Ed Owen (AUEM).

General appearance.—Body (Fig. 8-A) oval, 579 (514–622) long, 324 (309–343) wide. Dorsum.—Marginal setae (Fig. 8-B) 22 (19–27) long on head tapering to 15 (12–18) long near anal cleft, slender, curved posteriorly, distribution: 8 anteriorly between eyes, 2 on each side between eyes and anterior spiracular setae, 2 on each side between anterior and posterior spiracular setae, 16 on posterior of body. Three spiracular setae (Fig. 8-C) in each spiracular furrow; median setae 27 (25–32) long, lateral setae 8 (6–9) long. Large (4 μm) bilocular (Fig. 8-D) and simple disc (Fig. 8-E) pores in submedian and submarginal rows. Bilocular pores often bent in a bow-shaped configuration. Anal plates (Fig. 8-H).—Each plate with dorsum densely reticulated, 67 (63–70) long, 35 (31–37) wide; cephalolateral margin 44 (38–47) long, caudolateral margin 41 (40–44) long. Venter.—Antennae (Fig. 8-L) 169 (157–181) long. Legs (Fig. 8-M) 270 (261–279) long, microctenidia at tibial apex absent; tarsal digitules (Fig. 8-N) 47 and 32 long; claw digitules (Fig. 8-O) 24 (23–26) long; claws (Fig. 8-P) with denticle. Diagnosis.—Dorsal bilocular pores (>3 μm) which are predominantly bow shaped, in submarginal and submedian longitudinal rows occur only in *T. quadrifasciata*.

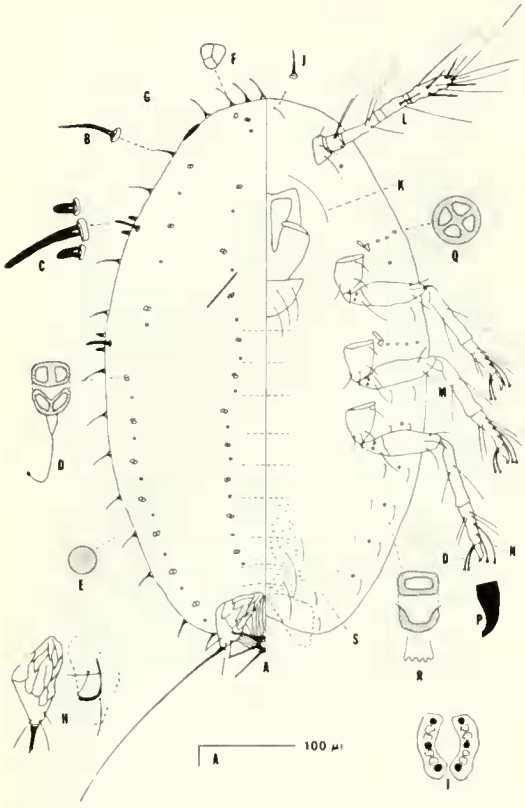

Fig. 8. First instar, *Toumeyella quadrifasciata* (Cockerell) 1895.

Fig. 9. First instar, *Toumeyella virginiana* Williams & Kosztarab 1972.

Toumeyella virginiana
Williams and Kosztarab
Fig. 9

Toumeyella virginiana Williams and Kosztarab 1972: 182, Hamon and Williams 1984: 126.

Specimens studied.—*Pinus:* 1(2), Auburn, AL, 26 Jun 1974, L. C. Ray (AUEM); 1(7), Pine Mt. Camp 35A, Harris Co., GA, 5 May 1979, K. Manuel (AUEM). *P. echinata:* 2(4), old water works road, Auburn, AL, 15 Aug 1974, MLW, J. Gilder, CHR (AUEM); 1(4), Bullock Co., Perote, AL, 26 Apr 1975, MLW (AUEM). *P. taeda:* 1(2), Dorchester Co., MD, 16 Sep 1971, MLW (AUEM); 2(4), Auburn, AL, 19 Jun 1974, L. C. Ray (AUEM); 1(2), Elmore Co., AL, 10 Aug 1974, CHR (AUEM).

Additional host plants and distribution.—*Toumeyella virginiana* has been collected on *Pinus elliottii, P. palustris,* and *P. virginiana.* Hamon and Williams (1984) report occurrence on *P. clausa* and *P. glabra.*

Toumeyella virginiana has been collected in FL and VA.

General appearance.—Body (Fig. 9-A) oval, 618 (330–965) long, 398 (318–681) wide. Dorsum.—Marginal setae (Fig. 9-B) 12 (10–16) long, slender, curved posteriorly, distribution: 8 anteriorly between eyes, 2 on each side between eyes and anterior spiracular setae, 2 on each side between anterior and posterior spiracular setae, 16 on posterior of body. Three spiracular setae (Fig. 9-C) in each spiracular furrow; median setae 20 (16–25) long, lateral setae 8 (5–12) long.

Small (2 μm) bilocular pores (Fig. 9-D) in submedian, submarginal and intermediate longitudinal rows. Simple disc pores (Fig. 9-E) in submedian and submarginal longitudinal rows. Anal plates (Fig. 9-H).—Each plate with dorsum coarsely reticulated; 73 (68–77) long, 34 (27–38) wide; cephalolateral margin 47 (38–52) long, caudolateral margin 45 (35–52) long. Venter.—Antennae (Fig. 9-L) 178 (152–196) long. Legs (Fig. 9-M) 232 (225–270) long, microctenidia (Fig. 9-N) at tibial apex; tarsal digitules (Fig. 9-O) 45 (36–51) and 29 (25–31) long; claw digitules (Fig. 9-P) 21 (19–25) long; claws (Fig. 9-Q) with denticle. Diagnosis.—*Toumeyella virginiana* appears quite similar to *T. pini* except for the presence of small dorsal bilocular pores in submedian, submarginal, and intermediate longitudinal rows. *Toumeyella pini* has dorsal bilocular pores in submedian and submarginal longitudinal rows only.

Discussion

The first-instar nymphs of all species of *Toumeyella* included in this study can be distinguished by morphological characters, but no means of distinguishing sexual dimorphism in the first instar were found. Also, no group characteristics were observed which would differentiate the *Pinus* feeding species of *Toumeyella* (*T. parvicornis, T. pini,* and *T. virginiana*) from those species associated with non-pine hosts (*T. cerifera, T. liriodendri, T. mirabilis, T. nectandrae,* and *T. quadrifasciata*).

The 8 first-instar *Toumeyella* described in this paper share many features with first instars of *Pseudophilippia quaintancii* Cockerell and *Neolecanium cornuparvum* Thro, most significantly 5-segmented antennae. Steinweden (1929) considered *Toumeyella, Neolecanium,* and *Pseudophilippia* as constituting one genus, while Williams and Kosztarab (1972) treated all three as valid genera. Comparison of *Toumeyella* first instars with descriptions of first instars of *Pseudophilippia quaintancii* and *Neolecanium cornuparvum* by Ray and Williams (1980, 1983) confirms the close relationship of the *Toumeyella* to these two genera and further justifies the placement of *Toumeyella, Neolecanium,* and *Pseudophilippia* in the tribe Toumeyellini. The invaginated bilocular pores of *P. quaintancii* are unique to that species and will separate it from all other Coccidae, but *N. cornuparvum* seems to fit well with *Toumeyella* based on comparisons of the first instar nymph and adult male. The dense pattern of bilocular pores of the adult female, however, suggests a closer relationship to other *Neolecanium* species. Preliminary investigations by the junior author indicate that some of the species currently placed in *Neolecanium* are actually closer to *Toumeyella* than other members of *Neolecanium.* Because of such confusion within the genus we feel it is premature to move *N. cornuparvum* from its current placement until a review of *Neolecanium* is conducted.

A ninth species, *T. sonorensis* (Cockerell and Parrott 1899), included in this study, has 6-segmented antennae and is not congeneric with the genotype, *T. mirabilis* or the remaining species studied, which have 5-segmented antennae. Preliminary investigations of the adult female morphology seem to indicate that *T. sonorensis* should be in a different genus than *Toumeyella,* but further revisionary work is needed before determining the placement of this species historically included in the *Toumeyella.* Additionally, distribution gaps within the United States and among temperate, neotropical, and tropical regions suggest further collecting in these areas is needed.

Acknowledgments

Thanks are extended to the museum staffs and institutions listed in the Materials and Methods section for the loan of specimens. Also, thanks to W. E. Clark and G. R. Mullen for manuscript review. This paper is published as Alabama Agricultural Experiment Station Journal Series No. 17-881785.

Literature Cited

Berger, E. W. 1922. Another apparently new entomogenous fungus from the hammock. Fla. State Horticultural Soc. 35: 68–71.

Burns, D. P. 1970. Insect enemies of yellow-poplar. NE. Forest Exp. Sta. USDA Forest Serv. Res. Paper NE-159. 15 pp.

Burns, D. P. and D. E. Donley. 1970. Biology of the tuliptree scale *Toumeyella liriodendri* (Homoptera: Coccidae). Ann. Entomol. Soc. Amer. 63: 228–235.

———. 1971. Quantitative field collection of honeydew. Ann Entomol. Soc. Amer. 64: 532–534.

Carnes, E. K. 1906. The Coccidae of California. Calif. State Commission of Horticulture. 70 pp.

Cockerell, T. D. A. 1895. New North American Coccidae. Psyche 7 (1894–1896) (sup.): 1–4.

———. 1897. New and little-known Coccidae from Florida. Psyche 8: 89–91.

———. 1899. Some notes on Coccidae. Acad. Nat. Sci. Phila. Proc. 1899: 259–275.

———. 1902. A contribution to the knowledge of the Coccidae. Ann. Mag. Nat. Hist. 9 (ser. 7): 450–456.

Cockerell, T. D. A. and P. J. Parrott. 1899. Contributions to the knowledge of the Coccidae. Industrialist 25: 159–165, 227–237, 276–284.

Cook, A. J. 1878. *Lecanium tulipiferae*. Can. Entomol. 10: 192–195.

Craighead, F. C. 1950. Insect enemies of eastern forests. USDA Misc. Pub. 657. 679 pp.

Craighead, F. C. and W. Middleton. 1930. An annotated list of the important North American forest insects. USDA Misc. Pub. 74. 31 pp.

Dietz, H. F. and H. Morrison. 1916. The Coccidae or scale insects of Indiana. 8th Report, Office of State Entomologist (1914–1915): 195–321.

Doane, R. W., E. C. Van Dyke, W. J. Chamberlin, and H. E. Burke. 1936. Forest Insects. McGraw-Hill, N.Y. 463 pp.

Dodge, B. O. and H. W. Rickett. 1943. Diseases and Pests of Ornamental Plants. Jaques Cattell Press. Lancaster, Pa. 638 pp.

Donley, D. E. and D. P. Burns. 1965. The tuliptree scale. USDA Forest Pest Leaflet 92. 5 pp.

———. 1971. The tuliptree scale. USDA Forest Pest Leaflet 92. 7 pp.

Felt, E. P. and W. H. Rankin. 1932. Insects and Diseases of Ornamental Trees and Shrubs. Macmillian Co., N.Y. 507 pp.

Fernald, M. E. 1903. A catalogue of the Coccidae of the world. Mass. Agr. Exp. Sta. Spec. Bul. 88. 360 pp.

Ferris, G. F. 1919. A contribution to the knowledge of the Coccidae of southwestern United States. Stanford Univ. Publ., Univ. Ser., Biol. Sci. 68 pp.

———. 1920. Scale insects of the Santa Cruz Peninsula. Stanford Univ. Publ., Univ. Ser., Biol. Sci. 1: 1–57.

———. 1921. Report upon a collection of Coccidae from lower California. Stanford Univ. Publ., Univ. Ser., Biol. Sci., 1: 61–132.

Gill, R. J. 1982. Color-photo and host keys to the soft scales of California. Scale and Whitefly Key #4. State of Calif., Dept. of Food and Agr. 8 pp.

———. 1988. The scale insects of California Part 1: The soft scales (Homoptera:Coccoidea:Coccidae). Calif. Dept. Food and Agr. Tech. Ser. in Agr. Biosystematics and Plant Path. No. 1, 132 pp.

Gmelin, J. F. 1789. Insects, Hemiptera, Coccus. Systema Naturae Ed. XIII: 2215–2222.

Hamon, A. B. and M. L. Williams. 1984. The soft scale insects of Florida (Homoptera: Coccoidea: Coccidae). Arthropods of Fla. and Neighboring Land Areas. Vol. 11. 194 pp.

Harned, R. W. 1923. A systematic and biological study of scale insects of Mississippi. Miss. Agr. Exp. Sta. 36th Ann. Rpt. (1922–1923): 19–36.

Heidel, W. and G. Kohler. 1979. *Toumeyella cubensis* sp. n. (Hemiptera: Coccinea-Coccidae)—a scale insect in Cuban orchards. Zool. Anz. 202: 132–144.

Hempel, A. 1929. Descripcoes de pulgoes novos e pouco con hecidos (Homoptera; Coccidae) 20a contribuicao. Inst. Bio. [Sao Paulo] Arch. 2:61–64.

Herrick, G. W. 1911. Some scale insects of Mississippi with notes on certain species from Texas. Miss. Agr. Exp. Sta. Tech. Bul. 2. 78 pp.

Hollinger, A. H. 1923. Scale insects of Missouri. Univ Mo. Agr. Exp. Sta. Res. Bul. 58. 71 pp.

Houser, J. S. 1918. Destructive insects affecting Ohio shade and forest trees. Ohio Agr. Exp. Sta. Bul. 332. 482 pp.

Howell, J. O. 1981. Utilization of first instars in scale insect systematics. *In* Occasional Papers from the Department of Entomology, Va. Polytechnic Institute and State University. Blacksburg, Va. Agr. Exp. Sta. pp. 23–27.

Howell, J. O. and H. H. Tippins. 1973. Immature stages of *Kuwanaspis howardi* (Homoptera: Diaspididae). J. Georgia Entomol. Soc. 8: 241–244.

Jarvis, T. D. and O. A. C. Guelph. 1911. The Coccidae of Canada. Report of the Entomol. Soc. of Ontario. 36: 64–77.

King, G. B. 1901. The Coccidae of British North America. Can. Entomol. 33: 333–336.

———. 1902. Further notes on Massachusetts Coccidae. Can. Entomol. 34: 59–63.

Knipscher, R. C., D. R. Miller, and J. A. Davidson. 1976. Biosystematics of *Chionaspis nyssae* Comstock (Homoptera: Diaspididae), with evidence supporting leaf and bark dimorphism of the scale. Wash. Sta. Entomol. Soc. 25: 1–30.

Kosztarab, M. 1977. Status of scale insects of forest

trees—an overview (Homoptera: Coccoidea). J. N.Y. Entomol. Soc. 85: 184–185.

Lepage, H. S. 1938. Catalogo dos Coccideos do Brasil (Homoptera-Coccoidea). Rev. Mus. Paul. 23: 327–491.

MacAloney, H. J. 1961. Pine tortoise scale. USDA Forest Pest Leaflet 57. 7 pp.

MacGillivray, A. D. 1921. The Coccidae. Scarab Co., Urbana, Ill. 502 pp.

McIntyre, T. 1960. Natural factors control the pine tortoise scale in the northeast. J. Econ. Entomol. 53: 325.

Merrill, G. B. 1953. A revision of the scale insects of Florida. Fla. State Plant Bd. Bul., 1 143 p.

Merrill, G. B. and J. Chaffin. 1923. Scale insects of Florida. Quart. Bul. Fla. State Plant Bd. 7: 177–298.

Milliron, H. E. 1959. A new *Anicetus* parasite of the Tuliptree scale (Hymenoptera: Encyrtidae). Ann. Entomol. Soc. Amer. 52: 28–30.

Orr, L. W. and R. C. Hall. 1931. An experiment in direct biotic control of a scale insect on pine. J. Econ. Entomol. 24: 1087–1089.

Pettit, R. H. and E. McDaniel. 1920. The Lecania of Michigan. Mich. Agric. College Exp. Sta. Tech. Bul. 48. 35 pp.

Pirone, P. P., B. O. Dodge, and H. W. Rickett. 1960. Diseases and Pests of Ornamental Plants. 3rd ed. Ronald Press Co., N.Y. 775 pp.

Rabkin, F. B. and R. R. Lejeune. 1954. Some aspects of the biology and dispersal of the pine tortoise scale *Toumeyella numismaticum* (Pettit and McDaniel) (Homoptera: Coccidae). Can. Entomol. 86: 570–575.

Ray, C. H., Jr. and M. L. Williams. 1980. Description of the immature stages and adult male of *Pseudophilippia quaintancii* (Homoptera: Coccoidea: Coccidae). Ann. Entomol. Soc. Amer. 73: 437–447.

———. 1983. Description of the immature stages and adult male of *Neolecanium cornuparvum* (Homoptera: Coccidae). Proc. Entomol. Soc. Wash. 85: 161–173.

Sanders, J. G. 1909. The identity and synonymy of some of our soft scale insects. J. Econ. Entomol. 2: 428–448.

Sleesman, G. B. 1945. The Coccidae or scale insects of Pennsylvania. Pa. Acad. Sci. Proc. 19: 43–48.

Smirnoff, W. A. and J. Valero. 1975. Effets a moyen terme de la fertilisation par uree ou par potassium sur *Pinus banksiana* L. et la comportenment de ses insectes devastaturs: tel que *Neodiprion swainei* (Hymenoptera, Tenthridinidae) et *Toumeyella numismaticum* (Homoptera, Coccidae). Can. J. For. Res. 5: 236–244.

Steinweden, J. B. 1929. Bases for the generic classification of the coccid family Coccidae. Ann. Entomol. Soc. Amer. 22: 197–245.

Taber, S. III, R. J. Barker, and Y. Lehner. 1975. Sugars collected by honey bees from honeydew of the scale *Toumeyella mirabilis* (Cockerell), on mesquite. Environ. Entomol. 4: 439–440.

Takagi, S. and S. Kawai. 1967. The genera *Chionaspis* and *Pseudaulacaspis* with a criticism on *Phenacaspis* (Homoptera: Coccoidea). Insecta Matsumurana 30: 29–43.

Thro, W. C. 1903. Distinctive characteristics of the species of the genus *Lecanium*. Cornell Univ. Agr. Exp. Sta. Bul. 209: 205–221.

Trimble, F. M. 1925. Scale insects injurious in Pennsylvania. Pa. Agr. Dept. Bul. 398. 8: 1–21.

———. 1928. Scale insects of Pennsylvania (Homoptera: Coccidae). Entomol. News 39: 42–47.

Ward, C. R., C. W. O'Brien, L. B. O'Brien, D. E. Foster, and E. W. Huddleston. 1977. Annotated checklist of new world insects associated with *Prosopis* (mesquite). USDA Tech. Bul. 1557. 115 pp.

Wells, A. B. 1926. Notes on tree and shrub insects in southeastern Pennsylvania. Entomol. News 37: 254–258.

Williams, M. L. and P. P. Cobb. 1982. Controlling pine tortoise scale in Christmas tree plantations. Proc. SNA Research Conf. 27th annual report Southern Nurserymen's Assoc. pp. 93–94.

Williams, M. L. and M. Kosztarab. 1972. Insects of Virginia no. 5. Morphology and systematics of the Coccidae of Virginia, with notes on their biology (Homoptera: Coccoidea). Va. Polytech. Inst. and State Univ. Res. Div. Bul. 52. 215 pp.

Wilson, C. E. 1917. Some Florida scale insects. Fla. State Plant Bd. Quart. Bul. 2: 2–65.